

REMARKS

Claims 1, 3, 4, and 6-21 were pending in the application. By this amendment, claims 7 and 9 are being canceled without prejudice, so that claims 1, 3, 4, 6, 8 and 10-21 remain. No new matter is involved. Reconsideration and allowance are respectfully requested.

Beginning with paragraph 1 on the first page of the Office Action following the Office Action Summary, the various claims are rejected under 35 U.S.C. § 103(a). The bases for such rejections are Hayashida et al. combined with Suzuki et al., taken alone or in combination with other references including Kern, Gill et al. and Ilardi et al. In paragraphs 5 and 6 on the next to the last page of the Office Action, applicant's arguments are summarized, and in the following paragraphs bearing the same numbers, the Examiner's response to such arguments is set forth. These rejections are respectfully traversed for the reasons discussed hereafter.

Regarding independent claims 1 and 4, these claims read as follows:

1. A storage water used for storage of a silicon wafer in water, wherein the storage water contains Cu at a concentration of 0.01 ppb or less and a surfactant.
4. A method of storing a silicon wafer in water, comprising the steps of preparing storage water containing Cu at a concentration of 0.01 ppb or less and a surfactant, and storing a silicon wafer in the prepared storage water.

Thus, claims 1 and 4 are characterized in that the storage water contains Cu at a concentration of 0.01 ppb or less and a surfactant. According to this feature, an

object of claims 1 and 4 is to improve the particle-removing performance of the storage water and to prevent degradation of oxide dielectric breakdown voltage, which occurs more frequently when a surfactant is added to the storage water (see lines 10-13 of page 2 and lines 7-13 of page 12 of the specification), and therefore the claimed subject matter produces the unexpected effects that the addition of a surfactant to the storage water improves particle removal performance of the storage water, and degradation of the oxide dielectric breakdown voltage can be prevented (see lines 12-17 of page 6 and lines 5-8 of page 7 of the specification).

In rejecting claims 1 and 4, the Office Action states that Hayashida et al. describes storage water containing Cu of substantially the same concentration as the present application and surfactants, and Suzuki et al. describes the method for storage of wafers in water, and therefore claims 1 and 4 are obvious.

However, while Hayashida et al. describes a treating solution containing Fe at a concentration of 0.01 ppb or less and surfactants (see lines 11-14 of col. 8 of Hayashida et al.<sup>(5)</sup>), the reference neither describes nor suggests storage water containing Cu at a concentration of 0.01 ppb or less and a surfactant, and a storage method as set forth in accordance with the invention. Therefore, it is clear that Hayashida et al. does not disclose the features of claims 1 and 4.

Moreover, Suzuki et al. describes a method for storage of wafers in water. However, the central features of Suzuki et al. is that of storing silicon wafers in a aqueous hydrogen peroxide solution.<sup>(6)</sup> In other words, Suzuki et al. neither describes nor suggests that silicon wafers are stored in storage water containing Cu at a low

concentration and a surfactant, in the manner of claims 1 and 4 of the present application. Therefore, it is clear that Suzuki et al. does not disclose the features of claims 1 and 4.

Regarding the contention in the Office Action that one of ordinary skill in the art could derive the present invention by combining Hayashida et al. and Suzuki et al., Hayashida et al. describes a treating solution with an added surfactant, but the reference only describes that the surfactant is added therein as one example of various auxiliaries (see lines 11-14 of col. 8 of the reference). In other words, the addition of a surfactant is not intended to improve the particle-removing performance of the storage water. Furthermore, because the reference deals with a treating solution for silicon wafers, <sup>①</sup> but does not relate to storage water, the reference does not recognize the problem in accordance with the present invention that degradation of oxide dielectric breakdown voltage occurs more frequently when a surfactant is added to the storage water.

Furthermore, Suzuki et al. describes that silicon wafers are stored in storage water to which is added an aqueous hydrogen peroxide solution. However, the reference does not recognize that when a surfactant is added to the storage water, the particle-removing performance of the storage water can be improved, and degradation of the oxide dielectric breakdown voltage occurs more frequently.

On the other hand, the subject matter of claims 1 and 4 of the present application was arrived at by recognition that degradation of oxide dielectric breakdown voltage occurs more frequently when a surfactant is added to the

storage water (see lines 7-13 of page 12 of the specification). Furthermore, based on the finding that when the Cu concentration of the storage water is 0.01 ppb or less, such degradation is not observed (see lines 22-27 of page 11 of the specification), Claims 1 and 4 define subject matter which accomplishes the objects of improvement of particle-removing performance of the storage water and prevention of degradation of oxide dielectric breakdown voltage by having Cu at a concentration of 0.01 ppb or less and a surfactant in the storage water.

Accordingly, one skilled in the art would not be lead to combine Hayashida et al., which describes a treating solution containing Fe at low concentration and a surfactant, but which does not describe the effect and problem in the case of using the above solution, with Suzuki et al. which only describes storage water with an added aqueous hydrogen peroxide solution. Moreover, even if Hayashida et al. were to be combined with Suzuki et al., neither reference describes that by containing Cu at a concentration of 0.01 ppb or less and a surfactant in the storage water, the degradation of the oxide dielectric breakdown voltage, which occurs more frequently when a surfactant is added to the storage water, is prevented. One of ordinary skill in the art cannot derive the subject of claims 1 and 4 of the present application from such a combination.

Inherently, contamination control in Suzuki et al. is directed at a residual etchant in a previous process, toward cleaning (see lines 18-35 of col. 2 of Suzuki et al.), but is not directed at Cu ions. In Suzuki et al., it is considered that this is because the chemical liquids remaining in the water are dissolved in the aqueous

hydrogen peroxide solution and are dispersed to extremely small concentrations therein. At the same time, the etching action of the chemical liquids exerted on the wafer surface is obstructed in some form or another by the hydrogen peroxide that an aqueous hydrogen peroxide solution is added to the storage water (see line 61 of col. 3 through line 7 of col. 4 of Suzuki et al.).<sup>(8)</sup> Therefore, contamination control in Suzuki et al. is not directed at metal, and in particular, Suzuki et al. neither describes nor suggests contamination of Cu.

Hayashida et al. relates to a treating solution, and the reference mentions that treatments described therein are remarkably effective for removing metal contamination such as Cu or Ag (see lines 19-34 of col. 1 of the reference). Generally, after wafers are polished, they are stored in storage water, and they are then subjected to cleaning. Therefore, because Cu ions which existed on the wafer can be eliminated by cleaning, one of ordinary skill in the art would not intend to prevent Cu contamination when wafers are stored in water, which is a previous process directed toward cleaning.<sup>(9)</sup> Furthermore, there is no basis for combining the storage method of Suzuki et al., in which contamination control is not directed at Cu, with the treating solution of Hayashida et al.

In contrast, the present inventor analyzed the causes of degradation of oxide dielectric breakdown voltage, and found for the first time that such degradation occurs even when the concentration of Cu in the storage solution is very low, and even if the wafers are subjected to sufficient cleaning. Therefore, the subject matter of claims 1 and 4 of the present application evolved (see lines 11-27 of page 11 of the

specification). Namely, it would appear that when Cu, especially when in the form of Cu ions, exists in the storage water, it electrochemically reacts with Si to precipitate, so that defects are generated on a silicon wafer. As previously described, if defects are formed on a silicon wafer, Cu which existed on a surface of the wafer can be eliminated, but the defects cannot be eliminated even if a treatment such as SC-1 is conducted. Also, an oxide film formed on a wafer occurs degradation of oxide dielectric breakdown voltage due to the defects. Therefore, the present inventor believed that decreasing the Cu concentration was very important as a measure for degradation of oxide dielectric breakdown voltage (see lines 1-6 of page 12 of the specification).

Consequently, decrease of Cu concentration in the storage water according to the present invention results from the analysis of the inventor as described above, and because Hayashida et al. and Suzuki et al. neither describe nor suggest that degradation of oxide dielectric breakdown voltage occurs due to Cu in the storage water, the present invention cannot be derived from the two references.

Moreover, contamination in Suzuki et al. causes small pits on the wafer surface due to etching, and even after cleaning the pits cannot be repaired. This is because the wafers in Suzuki et al. must be stored in storage water to which an aqueous hydrogen peroxide solution is added. On the other hand, and as described in Hayashida et al., it has been considered that Cu contamination can be easily eliminated by cleaning after storage. In view of this, one skilled in the art would

certainly not take the treating solution of Hayashida et al. and apply it to the storage method of Suzuki et al. to prevent Cu contamination.

Inherently, Hayashida et al. only describes water containing Fe at a low concentration. The reference does not describe water containing Cu at a concentration of 0.01 ppb or less in the manner of the present invention. Therefore, even if one of ordinary skill in the art were to combine both references, it is impossible to arrive at storage water in the manner of claims 1 and 4 which provide for Cu at a concentration of 0.01 ppb or less and a surfactant. Claims 1 and 4 of the present application have unexpected effects which one of ordinary skill in the art would not normally expect, and that is that the addition of a surfactant to the storage water improves the particle removal performance of the storage water, and degradation of the oxide dielectric breakdown voltage can be prevented (see lines 12-17 of page 6 and lines 5-8 of page 7 of the specification). Therefore, claims 1 and 4 are clearly patentable over the attempted combination of Hayashida et al. and Suzuki et al.

Claims 3 and 12 of the application read as follows:

3. A method of storing a silicon wafer in water, comprising the steps of preparing water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination, and storing a silicon wafer in the prepared water or a chemical solution.
12. A method of storing a silicon wafer in a storage solution, comprising the steps of preparing water or

a chemical solution containing a chelating agent, and storing a silicon wafer in the prepared water or chemical solution.

Claims 3 and 12 are patentable over the prior art for essentially the same reasons set forth above with respect to claims 1 and 4. More particularly, the contamination control of Suzuki et al. is directed at the residue in an etchant, and is not directed at Cu contamination. Also, wafers in Suzuki et al. have small pits on the surface as a result of etching, so that contamination control is required in storing the wafers in water. On the other hand, Hayashida et al. describes that Cu which exist on wafers can be eliminated by cleaning after storing the wafers in water. In other words, this is contrary to the teaching of the present invention, in which contamination control is required in storing the wafers in water.

(c) On the contrary, and based on the teaching that Cu contamination in storage water causes degradation of oxide dielectric breakdown voltage, claim 3 is characterized in that the silicon wafer is stored in prepared water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination. Claim 12 is also characterized in that water or a chemical solution is prepared containing a chelating agent, which is added to defuse Cu ions in the storage water.

Accordingly, one of ordinary skill in the art could not arrive at the subject matter of claims 3 and 12, in which the wafer is stored in water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination, from both references. Neither reference describes nor



suggests that Cu contamination in storage water causes degradation of oxide  
dielectric breakdown voltage.

Therefore, claims 3 and 12 clearly distinguish patentably over the attempted combination of Hayashida et al. and Suzuki et al.

Regarding claim 21, such claim reads as follows:

21. A regulating method of a storage water, wherein the  
concentration of Cu in the storage water is regulated  
to 0.01 ppb or less.

Thus, claim 21 is characterized in that the concentration of Cu in the storage water is regulated to 0.01 ppb or less, so that it has the effect that degradation of oxide dielectric breakdown voltage of the wafer generated due to Cu contamination in the storage water can be prevented (see lines 5-9 of page 10 of the specification).

It is asserted in the Office Action that claim 21 is obvious because there is a teaching of regulating the concentration of water, and according to Hayashida et al., it is necessary to control the Fe concentration in a cleaning solution within the same range adjusted by the claim of the present application (see lines 14-16 of col. 9 of Hayashida et al.). However, because a control method of impurity concentration in water has been conventionally known, there is no need to refer to Hayashida et al. The point is whether or not a control method of Cu concentration in storage water is obvious to one of ordinary skill in the art. Hayashida et al. relates to control of the concentration of a treating solution. As described therein, cleaning followed by water storage is remarkably effective for removing metal contamination such as Cu

or Ag (see lines 19-34 of col. 1 of Hayashida et al.). Therefore, the impurity concentration of the treating solution is controlled. From Hayashida et al., where Cu is eliminated in a cleaning process, one of ordinary skill in the art could not conceive that contamination control of Cu is required in water storage prior to a cleaning process. Accordingly, if there is no finding that Cu contamination in storage water causes degradation of oxide dielectric breakdown voltage, one of ordinary skill in the art would not realize that contamination control of Cu is required in storage water prior to a cleaning step.

Furthermore, and as previously described, Suzuki et al. describes a method of storage of wafers in water but does not relate to Cu concentration, and only describes concentration of the aqueous hydrogen peroxide solution in storage water. Moreover, contamination control in Suzuki et al. is directed toward the residue in an etchant, and is not directed toward Cu contamination.

Therefore, one of ordinary skill in the art would not be lead to combine both references. Moreover, even if both references were combined, the invention defined in claim 21 could not be derived from both references, because it would not be noticed that Cu contamination in storage water causes degradation of oxide dielectric breakdown voltage.

Accordingly, claim 21 involves unexpected results, which results would not come from either reference, namely that degradation of oxide dielectric breakdown voltage which occurs due to the Cu contamination can be prevented (see lines 5-9 of

page 10 of the specification). Therefore, claim 1 clearly distinguishes patentably over Hayashida et al. and Suzuki et al.

In conclusion, independent claims 1, 3, 4, 12 and 21 are submitted to clearly distinguish patentably over the prior art, for the reasons discussed above, and should be allowable. The remaining claims depend from such claims and contain all of the limitations thereof, so that such claims should also be allowable. More specifically, claims 1, 3, 4, 6, 8, and 10-21 are submitted to patentably distinguish over the art.

Reconsideration and allowance are respectfully requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles telephone number (213) 337-6846 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

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